

**IMPROVED IP UTRAN****Cross Reference To Related Application**

This application claims priority of European Application No. 01302131.6 filed on March 8, 2001.

**BACKGROUND OF THE INVENTION****1. Field of the Invention**

This invention relates to the use of the Internet Protocol (IP) in the UTRAN, i.e. the Terrestrial Radio Access Network of the Universal Mobile

5 Telephone System (UMTS).

**2. Description of Related Art**

With the rapidly increasing use of IP, which is a simple, unified and cost-effective inter-working technology, IP has become one of the key transport and inter-working protocols in UMTS. Attempts have been made to  
10 replace the Asynchronous Transfer Mode (ATM)-based bearer in the UTRAN, with the aim of improving transport efficiency, maintaining Quality of Service (QoS) for both signaling and user data as well as maintaining control flexibility, and scalability of IP.

One technique which has been used is Lightweight Internet Protocol  
15 Encapsulation (LIPE) using User Data Protocol IP (UDP/IP), which has the disadvantage that it multiplexes multiple radio frames at the user level over UDP which adds control complexity. Another technique is Point to Point Protocol (PPP) multiplexing, in which PPP is used to carry multiple user data frames, which has the disadvantage that it applies only to point-to-point links  
20 between the Radio Network Controller (RNC) and the Node B so its use is limited.

**SUMMARY OF THE INVENTION**

An object of the present invention is to provide a technique which  
25 allows simple and effective transparent transport of user traffic and signaling in the UTRAN, facilitating the achievement of IP UTRAN, and providing an end-to-end IP solution to future UMTS architectures.

According to the invention a UTRAN comprising at least one first Radio Network Controller and at least one Node B associated with said Controller across an Iub interface, the Controller and the Node B operating Internet Protocol, characterized in that, when there is a requirement for signaling and/or data traffic to cross the Iub interface, the Radio Network Controller is arranged to set up at least one IP tunnel across the Iub interface, and signaling/data information are encapsulated in IP packets.

Preferably a similar IP tunnel is also arranged across the Iur interface between the first Radio Network Controller and a further Radio Network Controller.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

In the figures, Figure 1 illustrates the prior art UTRAN in the UMTS.

The invention will be described with reference to figures 2 to 6 in which:-

Figure 2 shows the components of an all IP UTRAN and its interfaces;

Figure 3 shows the expanded channel frame structure with the inventive Transport Channel ID (TCHID);

Figure 4 illustrates schematically the control plane of an all-IP UTRAN interface;

Figure 5 shows the Iub interface protocol structure; and

Figure 6 shows the logical model of an all-IP Node B for Frequency Division Duplex (FDD).

#### **DETAILED DESCRIPTION**

Figure 1 shows a conventional arrangement of a part of the UMTS. A Mobile Terminal (MT) 12 connects to a UTRAN 14. The UTRAN connects across an Iu interface to a Serving GPRS Support Node (SGSN) 16, which connects across an interface to a Gateway GPRS Support Node (GGSN) 18. The GGSN 18 connects to the Core Network (CN) 20.

Figure 2 shows a part of the Figure 1 network, i.e. the UTRAN and

adjacent components. MT 22 is supported by Node B 24 which is controlled over an Iub interface by a Controlling Radio Network Controller (CRNC) 26. CRNC 26 communicates across an Iur interface with a Serving RNC 28, which is connected to CN 22. Node B 24 and CRNC 26 together constitute the UTRAN, which is now an IP UTRAN.

In the inventive IP UTRAN, IP tunneling is used across the Iub and Iur interfaces. IP packets are used to encapsulate the Session Data Units (SDUs) and Protocol Data Units (PDUs) of layers 2 and higher protocol layers over the two interfaces. Both signaling and user data are included.

The IP-based Iub/Iur interface protocol stack is :-

Iub/Iur Transport Channels

Mux/Demux sub-layer

IP

DL/PHY

where DL is Down Link and PHY is the Physical Layer (???)

The transport channels in the interface protocol stack are the conventional ones in UMTS/GPRS, i.e. the Dedicated Channel (DCH); Forward Access Channel (FACH); Random Access Channel (RACH); Common Pilot Channel (CPCH); Downlink Shared Channel (DSCH); and Uplink Shared Channel (USCH).

The selection of a transport channel for the tunneling of IP packets is performed by the conventional packet scheduler in CRNC 26, the selection being based on factors including

servers type or bearer parameters, for example delay requirements data amount

load of the common channels and shared channels  
interference levels in the air interface  
radio performance of different transport channels.

- For dedicated network links between Node B 24 and CRNC 26, a
- 5 common IP channel can be used to tunnel both user and signaling traffic through the lub interface. For example, for the user plain of lub, the transport channels (as listed above) can be multiplexed through the same IP tunnel by using the existing raw IP transport option available in IPv4/IPv6. Multiplexing information is attached to the data frame in each channel.
- 10 Demultiplexing of the different transport channels uses the data frame information.

- The advantage of multiplexing the transport channels is the conventional one, i.e. IP packets have headers which are a minimum 20 bytes long. Radio frames can be very much shorter, so multiplexing
- 15 provides efficiency.

The advantage of IP tunneling is that fixed IP addresses can be used, as is conventional. Once a tunnel is in place, conventional IP routing is used.

- In one possible arrangement, the spare bits after the Session Data Unit (SDU) length are used to carry the Transport Channel ID (TCHID).
- 20 Typical codes are:-
- 001:RACH
  - 010:CPCH
  - 011: .....

- In an alternative arrangement shown in Figure 3, a one-byte field 23 is
- 25 allocated in the common header structure of the channel frames. The TCHID field in byte 4 is used by the mux/demux sub layer of the protocol stack to identify and demultiplex different transport channels which have passed through the shared IP tunnel.

- Instead of a shared IP tunnel, another possibility in the inventive IP
- 30 UTRAN is to use a dedicated IP tunnel, i.e. a specific IP tunnel is set up across the lur or lub interface for each of the transport channels. Dedicated

IP tunnels are useful when multiple access is required for several channels, for example on soft-handover.

- Turning now to the protocol arrangements, the general protocol structure in the conventional UTRAN consists of two main layers, the Radio
- 5 Network Layer and the Transport Network Layer which is based on ATM. All UTRAN related issues are visible only in the Radio Network Layer. The Transport Network Layer represents standard transport technology which is selected to be used for UTRAN without any UTRAN-specific requirements. Both have their specific User Plane and Control Plane. The Data Bearers in
  - 10 the Transport Network User Plane are directly controlled by the Transport Network Control Plane during real time operation, but the control actions required for setting up the Signaling Bearers (s) for Application Protocol (i.e. Radio Access Network Application Protocol (ie RANAP), Radio Network Subsystem Application Protocol (RNSAP) or Node B Application Part NBAP
  - 15 used for setting up bearers i.e. the Radio Access Bearer or Radio Link are considered O&M actions.

- In an all-IP UTRAN, the Transport Network Layer is now based on IP, as are the transport links for the lu and lub interfaces. This is illustrated in Figure 4; conventional features including the applications part App.Part;
- 20 Radio Resource Control; Radio Link Control; Medium Access Control; and Radio Frequency Physical layer are shown in the MT 22, Node B 24, CRNC 26 and SRNC 28. The IP layer is located above the DL/PHY layer.

Considering now the inventive IP lub interface between Node B 24 and CRNC 26; the information transferred over the interface includes:-

- 25 I the Radio Application Related Signaling
- II Data Streams
  - i the lub/lur DCH data stream
  - ii the lub RACH data stream
  - iii the lub FDD CPCH data stream
  - 30 iv the lub FACH data stream
  - v the lub TDD USCH data stream

vi the lub PCH data stream

Figure 5 shows the IP lub interface protocol structure. There are two functional layers. The first is the Radio Network Layer 30 which defines  
5 procedures 32 related to the operation of Node B 24. The Radio Network Layer 30 consists of a radio network control plane 34 and a radio network user plane 36; the user plane 36 comprises the F... P... of each of the transport channels shown at 38.

The second functional layer is the transport layer 40 which defines  
10 procedures for establishing physical connections between Node B 24 and the CRNC 26 as indicated at 42. The transport layers includes the UDP/IP protocol at 44.

There is one dedicated AAL2 connection for each RACH, for each FACH, and for each CPCH, where AAL2 is a type of Asynchronous  
15 Transport Mode (ATM) Adaptation Scheme which allows multiplexing traffic over the same ATM Virtual connection.

The transport channel mux/demux 46 is also shown in the user plane  
36.

Figure 6 illustrates the infrastructure of an all-IP Node B 24 which  
20 deploys IP as a transport and data switching/routing mechanism to and from CRNC 26. Controlling RNC 26 has a number of ports 50, i.e. one port 52 as the Node B control port; one data port 54 for each lub transport (signaling?) channel, allowing multiplexing/demultiplexing at 46 when a shared IP tunnel is used, and one data port 56 for each lub (data channel?) providing,  
25 together with a communication control point 58, a traffic termination point 60. A second or further traffic termination points 62 may be provided with similar structures.

On the Node B side, the multiplexer 46 links to common IP/DL/PHY or MPLS (Multi Protocol Label Switching) transport channels, as indicated at  
30 70, and the traffic termination points linked to Node B communication context 72. The Node B control port 52 and the communication control port 58 each

connect to the cells 80 of Node B 24.

When dedicated IP tunnels are provided across the lub interface, multiplexer/demultiplexer 46 is omitted but the remaining structure is still used.

- 5        When IP tunnels are used to transport the user data and signaling channels across the lur interface between CRNC 26 and SRNC 28 a very similar arrangement to that of the lub interface is used.

- 10       Although the invention has been described with reference to a single Node B associated with a RNC, simple duplication allows IP tunnels across the lub interface to two or more Node Bs controlled by one RNC.

The arrangement according to the invention conforms to the general requirement for an all-IP UTRAN in that it supports:

- fast and efficient radio resource access and allocation control and management;
- 15       no or minimal impact on existing Radio Network Layer functionality of the UTRAN;
- open interfaces between Node B and RNC as well as between RNC and CN; and
- the QoS requirements of both Signaling Bearers and Data Bearers.
- 20       The specific advantage of the tunneling arrangement and use of transport channels are that there is flexibility of providing both point-to-point links (e.g. PPP) and routed network links between Node B and RNC over the lub interface, and also over the lur interface between RNCs.